SCIENCE AND THE CITY

"I propose that we focus all the techniques and talents within our society on the crisis of the American city."

President Lyndon B. Johnson

FOREWORD

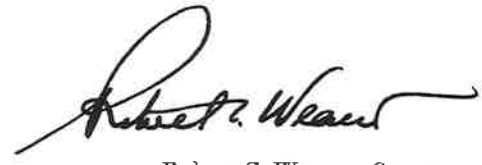
During the next three or four decades, the United States will need to build and replace more homes, apartment buildings, factories, commercial buildings, and other urban facilities than we have built since the landings at Jamestown and Plymouth Rock. By the year 2000 the urban population will more than double.

This extraordinary growth, coupled with the need to replace decay and obsolescence and to meet rising public demands for quality of living, means that new approaches must be found to provide the needed physical facilities and social environment on a scale not previously contemplated.

New technologies and concepts must be developed if the physical environment of our cities is to be brought up to modern standards at cost levels which will be feasible either for government or individual citizens. The kind of forced-draft technological effort that has characterized the development of space and weapons systems needs now to be applied to the urban task.

To assist in designing new approaches, the Department of Housing and Urban Development and the Office of Science and Technology in the Executive Office of the President sponsored a three-week Summer Study on Science and Urban Development in June 1966 at the National Academy of Sciences Summer Study Center in Woods Hole, Massachusetts. Approximately 50 non-government scientists and urban specialists participated, assisted by skilled staff from several Federal agencies and departments.

This report on Science and the City is based on the discussions and recommendations of the Summer Study panels. It is intended to give perspective as to how science and technology can be brought to the service of the city rather than specific, immediate solutions. I believe the new directions and the clear opportunities outlined here make a major step forward in building the cities America deserves.



Robert C. Weaver, Secretary
Department of Housing and Urban Development

CUES FOR INNOVATION

The urban population of the United States is increasing faster than the total population. Even our most magnetic cities contain drab fields of decaying housing, poorly served by transportation, sanitation, and other systems. Millions of homes have ceased to function, and poverty retards revitalization of them.

Can we make our cities safer and happier? Do we have the resources and skills? Must so many people dwell in hovels while we are conquering space?

Four dozen leaders in science, engineering, and urban affairs studied these questions for three weeks in June, 1966, at Woods Hole, Mass.

Yes, they agreed, the United States can do things it never could before. Our resources and skills are growing. We are learning more about people's requirements. Creating a safe, happy city is a greater challenge than a trip to the moon because urban housing is more complex than a rocket and the city is subject to more perturbations than the moon. Its ever-changing problems, nevertheless, can be attacked in the same logical way we have gone about exploring the universe.

We are more certain about the city's past than we are about the moon's history. Men created the city in response to their need in a primitive agricultural society for an information and control center. It was often walled. Their further inventions such as printing increased its importance as a center of enlightenment. The walls are gone now. Our mobility is greater but many parts of the city have been left a shambles.

"Men work together," Robert Frost wrote, "whether they work together or apart." Practitioners of every art and science have had hands in producing the modern city. Many of them, however, have worked apart—striving to increase the fruits of their labor in different ways and for sometimes conflicting purposes. To strengthen and save the city, men skilled in every art and science must work more truly together.

A Modern Invention

Although comparing a city to a spaceship may seem absurd, both are inventions produced by men. The speed with which spaceships have been built makes many men wonder why progress in urban affairs has not been accelerated, too.

Until a few decades ago the only space scientists were writers of fiction. Their stories were as hard to believe as the utopians' tales. The star-gazers' dreams, nevertheless, intrigued astronomers, physicists and biologists; mechanical, electrical and aeronautical engineers; and statesmen and businessmen. Suddenly it seemed, all we had to do to venture into space was to give clear cues to what was needed to a great many specialists.

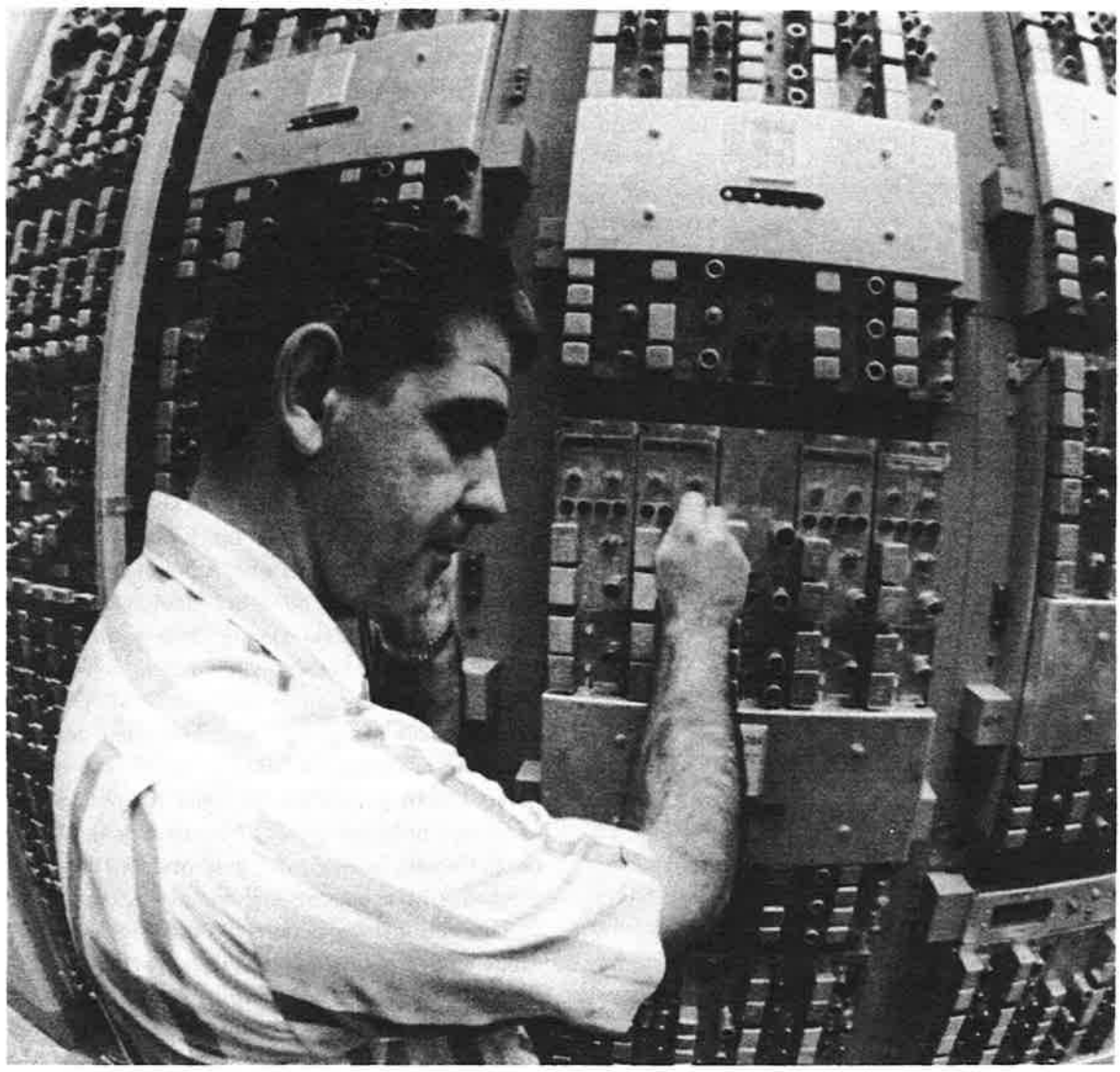
The space agency integrated the efforts of government, universities, and industry to put our country into the race to the moon. It did this with newly developed control and management tools. They showed what innovations were needed to produce spacecraft and ways were found to bring them about. The new agency, in other words, took what is called *a systems approach* to bringing together the diverse talents of thousands of persons.

Like an automobile, the Apollo spaceship is just a combination of systems for propulsion, guidance, and enclosing passengers. These systems consist of sub-systems like those that distribute electrical energy and chemical fuel to the cylinders of your car's engine.

Scientists often describe a complex machine as a combination of *black boxes*. Something or other goes into each *black box* and comes out changed in some way that makes it more helpful in making the whole machine run properly. The efficiency with which each *black box* does its job determines the demands placed on other parts of the mechanism. By making a lot of *black boxes* (or sub-systems) work together smoothly, engineers built the vehicles that now carry men to altitudes not attainable in the 1950's.

The city, too, consists of systems and subsystems. It has systems for assuring people's health, mobility, and cleanliness; systems for fighting fires, enforcing laws, and educating and entertaining its populace, all of which interact with each other.

Many of the sub-systems in our spacecraft weigh less, waste less power, and do things more reliably and precisely than devices of the same sort that were built a few years earlier for warplanes. Necessity mothered the inventions and



changes that resulted in these increases in efficiency. When specialists in this, that, and some other thing realized how all those things had to work together to put a man into orbit, it did not take them long to improve the performance of many sub-systems.

There is truth as well as sting in the quip that scientists learn more and more about less and less, but advances in science are made by fitting bits of knowledge together in new ways. By ingeniously putting *black boxes* together in new ways, we have also armed ourselves with new weapons. With new combinations of old but now more effective devices, stout-hearted men have begun to give us new views of the whole solar system.

A city, of course, is a much more intricate combination of systems and sub-systems than a spaceship. It must do more than take a few test pilots, gladly sacrificing their comfort for a few days, to a crater floor on the moon. The city must accommodate all kinds of people, grant privacy to families, and help them realize hopes more difficult to state in words and numbers. Urban people's safety and happiness depend not only on physical structures but also on their own biological needs and on the performance of economic and social systems.

The similarities between getting men to the moon and creating a city closer to the heart's desire, nevertheless, are impressive. As truly as a spaceship, a city is a product of men's thinking that can be overhauled, rebuilt, and improved.

We have experts on the operation of social as well as physical *black boxes*. Their talents and skills, however, have usually been brought to bear on urban problems helter-skelter, rather than by *a systems approach*.

A Social Innovation

The first step in attacking a set of questions via the systems involved is simple: You get experts on different parts of your problem together and focus their attention on it. You then ask these experts: What is needed? What can you and your peers do about it? And what have you to suggest?

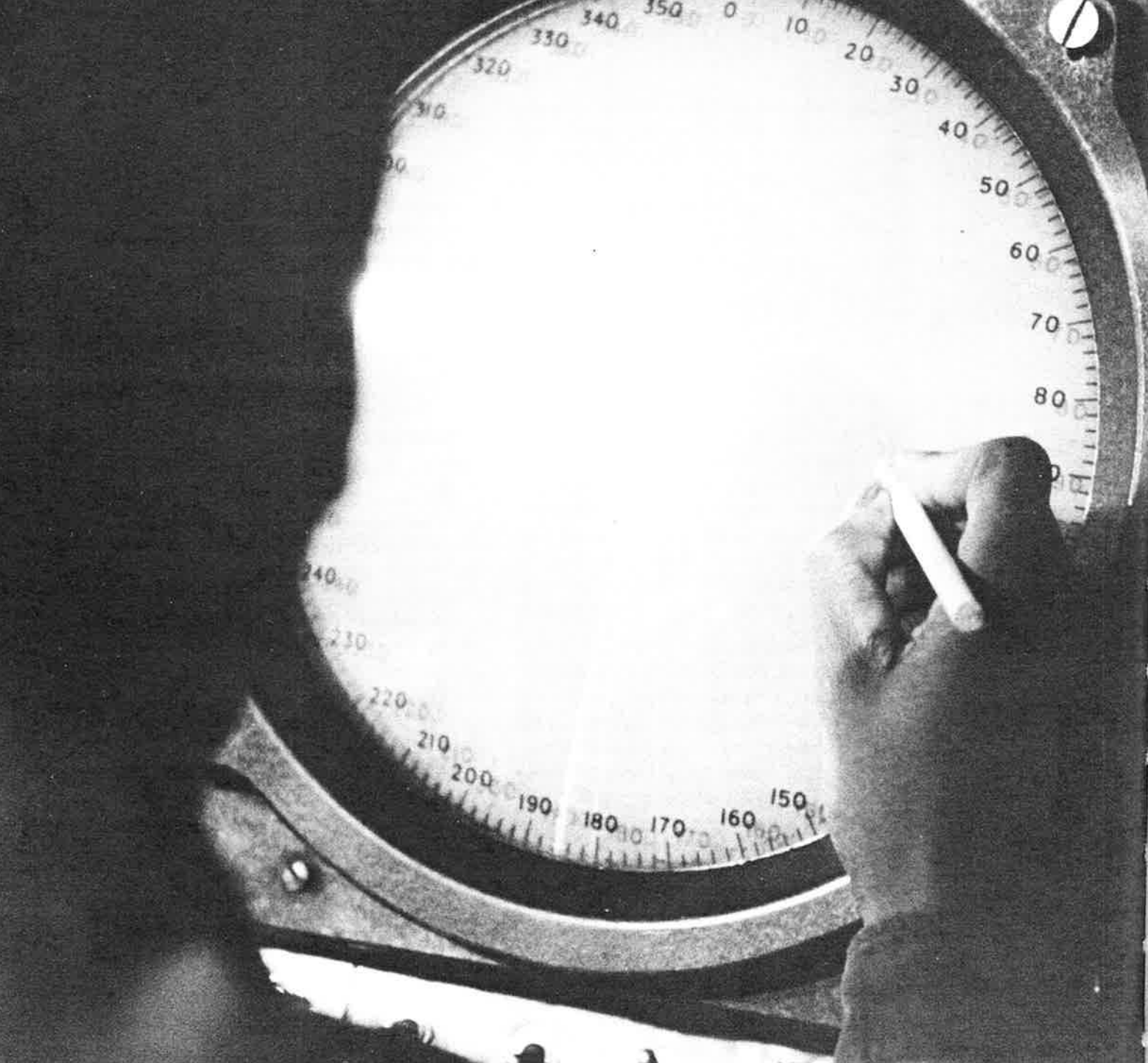
The Department of Defense has done this for many years. It organized Summer Study groups that suggested such additions to our country's armament as the Polaris missiles. The National Aeronautics and Space Administration has sponsored similar studies. Last June the new Department of Housing and Urban Development took a major step toward strengthening America's cities. With the help of the President's Office of Science and Technology, it arranged for a close look at the dismal inner parts of our cities by an interdisciplinary Summer Study group.

A seminar such as this one at Woods Hole differs markedly from the brief conferences at which students of the city often read papers to each other. It brings together men with more varieties of knowledge and experience, accustomed to different shop talk, and less familiar with each other's reputations and limitations. At Woods Hole the chairman was a professor noted for his use of computer techniques to study how the brains of cats and men process sensory information. His colleagues included physicists, lawyers, architects, economists, mathematicians, psychologists, and even a professor of zoology. Such men were able to illuminate some facets of the urban problem that those grappling with it daily sometimes perceive too dimly.

When viewed from different angles, the Summer Study found, the city resembles a garden tended by children with makeshift instruments and a multitude of different hopes. It has features so beautiful that no one would touch them, but others so frightful that everyone would like to remove or restructure them. There was concern such as Henry George's about "progress and poverty," the great enigma of our time as it was in the 1870's; but no one had a single, simple remedy for the city's sorry plight today.

In the chairman's words, the city is "a multi-component, multi-input, multi-output, multi-purpose set of structures," obviously too numerous for a few dozen men to review carefully in a few weeks. So the participants divided themselves into panels to look at only a sampling of the many systems involved—those concerned with people's health, their transportation, their housing, their environment, and the resuscitation of decadent neighborhoods.

By talking with each other, the Woods Hole specialists in a variety of arts and sciences found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Hospitals internationally famous for the help they can give people with certain exotic ailments often are poorly staffed and equipped to minister to the ills of families next door. The steep stairs and big brass doors to a richly endowed medical complex look forbidding and sometimes are to a poorly informed newcomer from rural Mississippi. Many clinics serving the poor are so rushed that the care a person gets is often belated, cursory, improper, and insulting to human dignity. Contacts between patients and doctors are too frequently random and discontinuous.

The files of welfare agencies, schools, and police courts are full of data indicative of the unfilled needs of the children of ethnic minorities, the poor, and the aged who dwell in the nuclei of cities. Very little of that information, however, is being fed to computers for analysis. We consequently have scarcely any profiles of the health service requirements of people in areas where infant mortality, mental illness, tuberculosis, dental defects, and narcotic addiction are rife. Nor do we have truly functional and accessible inventories of the resources available to us to deal with such menaces to everyone's welfare.

Computer profiles of human conditions, placed beside similar pictures of means of improving them, might show us how we could make better use of institutional facilities and individual doctors' skills. Although we can monitor the temperature and heart beats of astronauts hundreds of miles away, similar sensing and telemetering devices are being used only gingerly to alert doctors to physiological events in nearby hospital wards, prisons, and nursing homes. Although we are saving lives in Viet Nam with helicopters and more efficient techniques of dealing with casualties, ambulances still crawl and howl through 5 o'clock traffic jams in city jungles.

A Partnership in Health

Efforts to provide comprehensive health service to people more efficiently have begun in New York and New England. A Woods Hole panel reviewed these and more widely publicized ventures in group practice elsewhere, but was surprised by how few different models there now are for planners to study. The most comprehensive health service in the United States that anyone present knew about is in Puerto Rico.

Neighborhood health care centers, associated with general hospitals, which in turn had ties to teaching-research-hospital complexes, could screen and direct the poorly informed people in blighted areas to the best available sources of help. At such a center, a mother might get prompt treatment from a volunteer aide for her children's minor injuries and ailments, and be sped to a clinic or specialist when that is imperative. The on-site center's services might even

be multidisciplinary, and include information as to sources not only of medical therapy but also of financial, legal, and educational assistance.

Such centers could alleviate the effects of a shortage of doctors by reducing the waste of time of highly trained men. They also could be training places for paramedical aides to medical personnel such as the U. S. Navy uses effectively. By recruiting and training more nurses and other assistants to specialists in neglected neighborhoods, we could make better use of the knowledge and skills of graduates of costly medical, dental, and other colleges.

Although health services in the city could be better than ever now, they fall short of our hopes because we have not taken what the Woods Hole panel on the topic called "a partnership approach" to distribution of them. This system should be one, the panel reported, "in which all appropriate agencies on federal, state, and local levels contribute funds, manpower, and ideas towards the common goal of optimum health status."

Particles and Waves

Many different kinds of urban difficulties could be lessened, like battlefront casualties, by transporting men in new ways.

An explorer of our society from another planet might well marvel at our ineptness in using city streets in view of our adeptness in using strands of wire. Whereas Samuel F. B. Morse could only send one message at a time through a wire in 1845, we currently send dozens simultaneously. The wire is no larger, but we use it better. Mathematical resolution of communication phenomena has enabled us to do this. Similar analyses of transportation systems have shown that our use of city streets is about as primitive as Mr. Morse's use of a wire. Their carrying capacities, too, could be increased.

The electronic engineers have numerous techniques for increasing a channel's capacity. One is to digitalize information, by counting bits of it separately from great waves. Sometimes only some bits are transmitted, then others are added at the receiving end of the line to reproduce a wave indistinguishable from the original one. Although it is not feasible to transport a man from one place to another the way we transmit his voice, it is quite easy to count the human heads rather than the vehicles flowing through city streets. This suggests several different ways of getting waves of people through streets faster.

In cities, of course, street intersections are numerous and troublesome—but often excessively so. We control the traffic flow through many busy intersections with crude signal lights. They cannot distinguish between a bus carrying 50 persons and a lone boy on a motorcycle. It would be quite easy to enable them to do this—by putting beepers in the buses (that would not disturb even a dog's slumber) and receivers in

the signal light boxes. The control mechanism then could delay one person a few seconds to save 50 people that many seconds. Such electronic devices are becoming cheaper and would soon be tried if we seriously set out to maximize the flow of people rather than the flow of vehicles.

Even simpler devices than sensitive signal lights might improve the bus service in many cities: sidewalk displays of routes and schedules; machines on the curb from which passengers could buy tokens; call boxes at seldom used stopping points along bus routes; "next-stop" displays inside the vehicles; two way radio communication between bus drivers and traffic control centers.

Although electronic aids have made dynamic scheduling feasible, most city bus systems are still run as if radio had not been discovered yet. The Summer Study showed that changes could be made quickly which would make riding in multi-passenger vehicles more nearly like having a private car.

We have grown accustomed to thinking that a vehicle must carry a great many or only a very few persons, although this clearly is not so. Some of our transportation costs could be reduced by using vehicles of different sizes and controlling their routes better.

Suppose, within an area two miles by two miles, 1200 persons per hour wanted to get to the same destination from random points. Suppose you wanted to make the average trip time only 5 minutes, starting 10 minutes after each person telephoned that he was ready to go. How many vehicles would you need? If each one could carry 10 persons, you would need only 20 cars to provide such taxi-like bus service. Such vehicles now take people to airports from hotels in many cities, and some communities are experimenting with "minibuses" for shoppers.

Three times as many passengers ride buses as use other public transportation systems. Many more people might if most buses were not so hard to get in and out of, so smelly, so noisy, and so frequently as crowded as primitive space capsules. Many people are too young, too old, too handicapped, or too poor to drive private cars; others would prefer good bus service to practicing for stockcar races. Unfortunately, the major urban bus maker in the United States has faced a market more responsive to the state of individuals' purses than to the requirements for efficient use of old streets.

Communication engineers have learned how to build many different kinds of sensing and control systems and have embodied such concepts in hardware that can perform many tasks sooner and more reliably than human beings can. A robot surveyor sent to the moon in 1966, for example, landed on its feet where it was told to land and sent home 10,000 photographs better than most tourists' snapshots. It is equally feasible now to build a computer capable of driving 10,000 vehicles safely while their occupants all read books.

Designing, building, and installing a system to drive 10,000 vehicles to hundreds of different places, of course, is a challenge comparable to providing supersonic transoceanic transportation. It can only be met in a reasonable time by a systematic study of all the obstacles, ways of surmounting them, and the possible consequences. Such a system, however, may someday make mass transportation less different than having a private car.

The Woods Hole panel on transportation suggested that in addition to considering how we make long trips, we consider possible improvements in our means of making short trips. Must changing from one mode of travel to another be as strenuous as it often is to get from a railroad terminal to an air terminal? Why do we not have easier ways to enter and leave subways than iron stairs? Why must there be so little space in which to walk in some cities? And wouldn't it be nice if places where we could rest our feet were not always so far away?

Today's urban health and mobility systems unquestionably are superior to yesterday's and for these improvements we are indebted to both the public and the private sectors of our economy. Transportation systems, nevertheless, would be much less irritating if the efforts of public and private spenders were coordinated, the way a wise man makes appropriate use of both his right hand and his left hand.

THE CASTLES OF MILLIONS

Housing's function throughout history has been to help the family of man realize healthy aspirations without discomfort. It gratifies emotional and aesthetic as well as physical needs. It gives us privacy, nourishes our self-respect, and helps us be hospitable to each other. Without good housing, the city would still be a camp in which no man's home could be his castle.

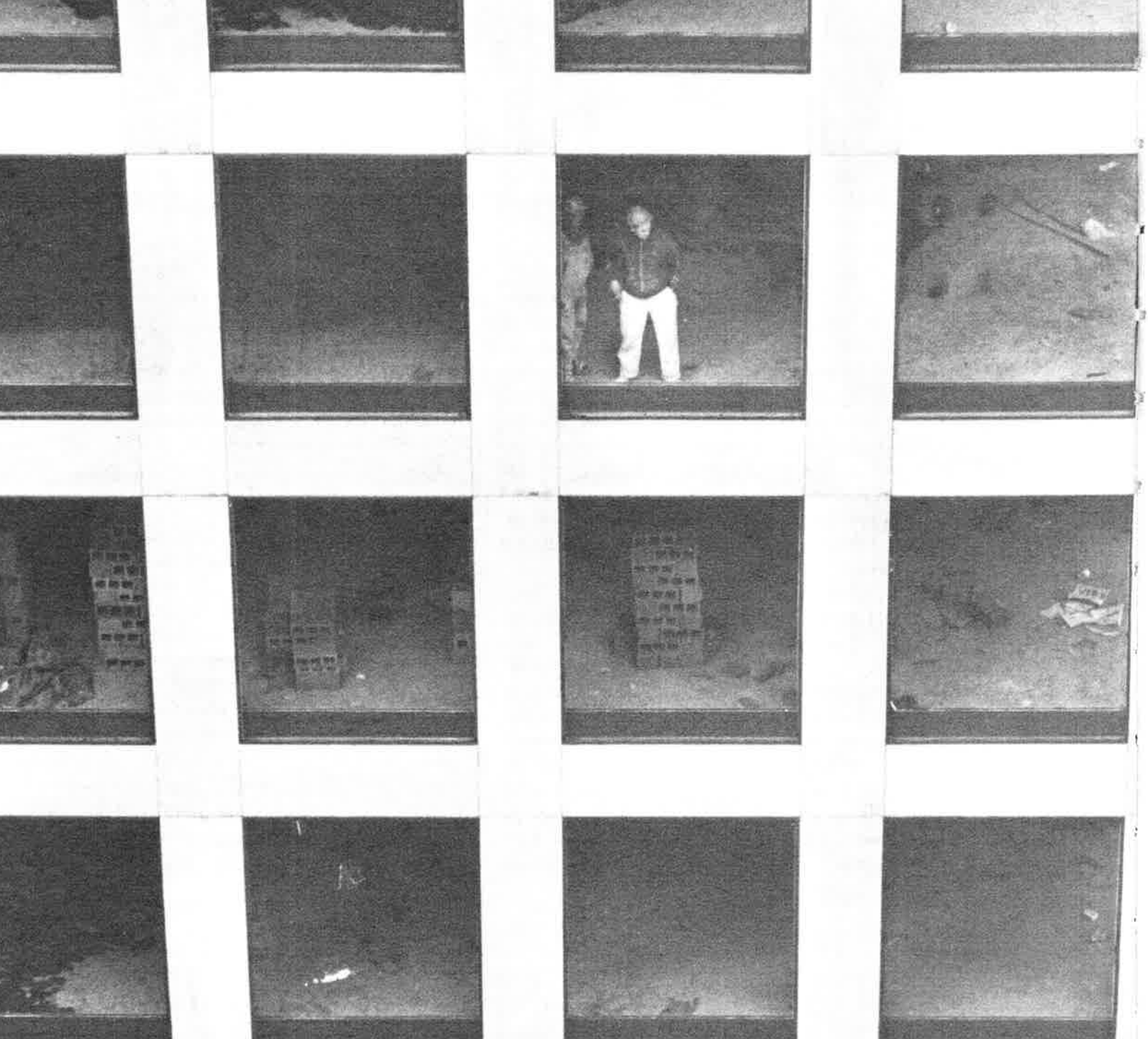
Urban housing not only shelters us from storms, rats, and grasshoppers but also shields us from harassment by hordes of other folk. The armor that it gives to each person is interlaced with that of every other person. This as well as the scarcity of space makes urban housing more costly than a home on the range.

The details of urban housing profoundly affect its occupants' demands on the city's other physical facilities and social institutions. A lighted place in which children play at dusk lightens a policeman's lot; refuse storage places in tenement basements reduce the litter in the street. The happiest neighborhoods are those in which the physical facilities and the social systems are happily married.

Strange Placements

The varying densities of people per acre in American cities intrigued the scientists at Woods Hole. The molders of our cities were often too busy making steel, butchering hogs, and doing innumerable other things to select, to shape, and to place their cities' massive parts the way an architect would those of a cathedral. Hence people are often found packed together in clusters in unattractive ways and places.

Everyone now knows that atoms that are friendly when far enough apart become fearsomely explosive when enough of them are so compressed and arranged that a stray cat called



a neutron can start a chain reaction among them. We know that human beings, too, generate energy from togetherness and that they are far more delicate than atoms.

It is also common knowledge that the populations of cities change swiftly and continually. Everyone has seen the moving vans carrying the paraphernalia of prosperous people out of the central city to the green pastures on its edges. Everyone has read about the tide of the poor and poorly treated folk flowing into the housing left behind by more fortunate families. Television commercials remind us ad nauseam that this is an age of rising aspirations. Yet the riots in our cities in 1966 startled and shocked us.

Central heating, floor carpeting, and elevators reduce frictions resulting from people's proximity to each other. The list of such aids is growing, but we can only guess about each one's value. How much, for example, do intercoms, balconies on apartments, roof-top swimming pools, and basement garages contribute to tranquility in public streets? Although we know precisely what control rods are needed in atomic piles, our knowledge of the requisites for good citizenship when people are jammed together is still fragmentary.

The architects at Woods Hole talked of *land area ratios* (LARs) and *dwelling units* (DUs) per acre. The engineers pointed to slums with high LAR values and 240 DUs per acre, then to Chicago's Marina City whose LAR is only half as big and which has 500 DUs per acre. Builders can now house tremendous numbers of persons comfortably on a few acres, and still leave parks and playgrounds much wider than nineteenth century alleys between the structures.

No one is certain, however, how much more space American families must have than men in barracks. Everyone at Woods Hole saw that single men and women, the very old, and the very poor frequently demand much less room than prosperous, growing families, but no one knew how widely such requirements vary. Builders are still striving to meet this wide range of needs in ways reminiscent of those by which the alchemists tried to make gold.

With computers mathematicians can generate models to help us review and compare many of the effects of clustering various kinds of people differently and in different areas. We have new tools with which to depict and compare possibilities on paper. But are we using them sufficiently and wisely?

Misuses of high-speed data processing systems have both annoyed and alarmed most of us. Proper usage of them, nevertheless, has made them as valuable in scientific laboratories as microscopes and telescopes. They can also be used to gain more insight into the interactions between housing, social characteristics, and social change.

"The absence of adequate theoretical or empirical information about densities applicable to cities," the housing panel reported, "has resulted in many irrational decisions based on standards for another age." If we used our electronic devices for theoretical studies of social phenomena, we might not have to shake our heads and wonder why when a neighborhood explodes.

The Migrant's Fate

You cannot take a house with you when you move into the core of a city. The parking lot attendants turn trailers away—although some engineers have suggested parking similar dwelling units vertically as well as horizontally.

If, like most newcomers, you are from a rural region you are likely to be a greenhorn about urban life, vulnerable to many traps and unscrupulous exploitation. Unless you can afford high-priced housing, you are pretty certain to find yourself moving into an ancient structure left behind by migrants to the countryside. The cost of new housing has gone up faster than most costs, and we are replacing less than 1 per cent of our housing per year.

Hand-me-down housing seldom fits the fiftieth occupants. If you are single, you are liable to have to take a room in a building designed for families. If you have children, you are liable to have to cram them and their pets into a makeshift apartment in a structure built for single-family rather than multifamily use. In such shelters you quickly learn that city walls are thin and that you must accommodate yourself to your housing rather than be accommodated by it.

An old urban structure is usually harder to keep habitable than a homestead built by your grandfather. The builders of city housing usually were more concerned about initial costs than maintenance costs. The cockroaches that one housewife drives out of her kitchen move into the kitchen next door. Even crickets, the entomologists have found, are harder to eradicate in the city than in the country. Replacing part of an old gas stove is seldom as simple as buying a new tire for a used car. Nobody makes the kinds and sizes of fixtures any more that you need for replacements in half-century-old houses. As such buildings degenerate, municipal services tend to decline, too.

Your neighbors, when you move into an old part of a city, are frequently newcomers as ill-prepared as you are to cope with archaic housing, go-go youngsters who have found life too quiet at home or in a domitory, and pathetic dropouts from life's rough schools: old gentlemen unable to drive private cars to and from their familiar haunts and old ladies determined to stay near a church, a grandchild, or a friend.

Your choice of a neighborhood is further restricted if your race or your religion differs

from that of the majority. Neighborhoods struggling to survive hold out for every cent that they can squeeze from an intruder, and contented communities combat change. The permanently rich and the seemingly forever poor families tend to segregate themselves. So do town and gown.

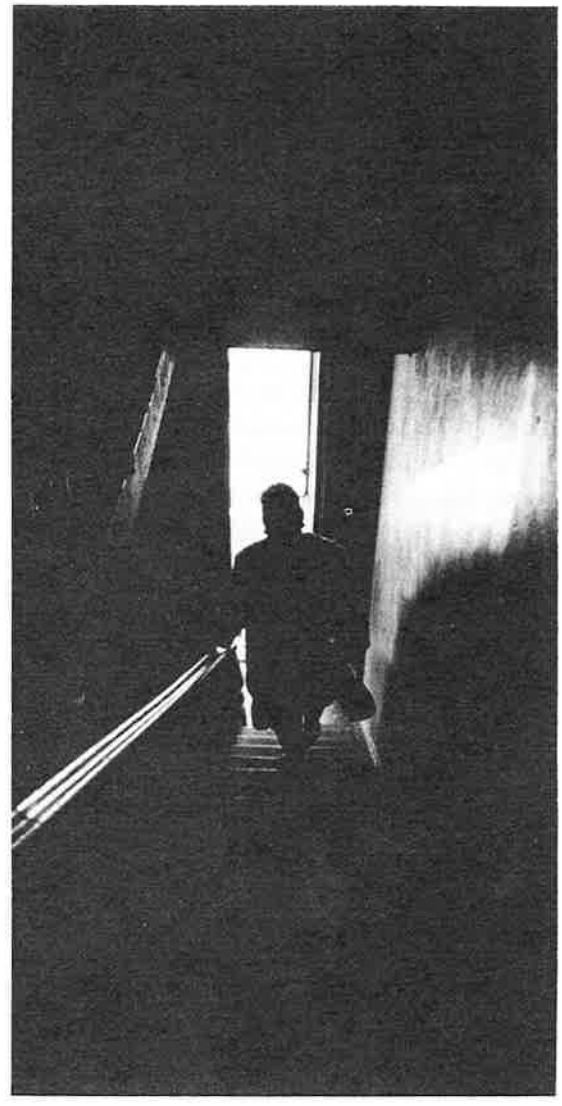
Those who can pay enough can usually find suitable shelter wherever they want it, but they are greatly outnumbered by those who cannot afford adequate housing in today's cities. Good housing has not been trickling down like good automobiles. We nearly always sell our cars for less than we paid for them, but frequently get more for housing after we have used it. Is it any wonder that cries in the night now carry far beyond the twentieth century ghetto's ghostly but high walls?

The Money Mountains

Excuses for the high cost of replacing the housing in the core and nearby sections of cities are plentiful The interdisciplinary group at Woods Hole looked into several of them. Its members found that the ridges in the money mountains between the people living in slums and the kind of housing they aspire to are high—but not necessarily impassable.

Three of the most conspicuous obstacles to reducing the cost of new urban housing are:

1. *The scarcity of land.* Absentee owners, disputing heirs, and speculators profit from



holding sites on which many people would like to live.

2. *Costly constraints.* Legal and financial requirements serve as treaties between vested interests to preserve the status quo.

3. *The construction industry.* Its fragmented structure has kept it from fighting costs with new methods and machinery as fiercely as, say, the auto or the chemical industries.

To venturesome engineers the scarcity of land looks like a figment of tired old men's imaginations. Reinforced concrete, stronger metallic girders, and new construction techniques are increasing the use of building sites on top of one another. New housing now can be built above almost anything, including old housing. Much more might be done if we tackled the density-of-people problem in the same logical and determined way that we have tackled the density-of-the-atmosphere problem to explore space.

To impartial observers, many city governments appear to have let their power to tax rust. If tax pressures were used to make it more advantageous to holders of slum lots to put them to better use, most owners would do it or sell them to invest elsewhere. Although some cities are giving tax concessions to landowners for improving structures, in most cities an heir's taxes go up if he modernizes a building that someone left to him.

Violations of housing laws now fatten some slum landlords' billfolds. These laws would be enforced better if there were more neighborhood welfare centers to which tenants could go for information and legal advice. Better enforcement of occupancy laws could reduce the cost to the whole city of health, sanitation, and other services.

Updating building codes would remove constraints that prevent economies in construction. By specifying the materials and methods that builders must use, old codes prevent innovations such as plastic piping and new structural components.

To conquer space and atoms, engineers have devised testing systems by which the reliability and lifetime of nearly anything that a factory can produce can be predicted. Automatic nondestructive testing equipment is becoming less expensive. Its use is making it feasible to substitute performance requirements and reliability tests for materials specifications.

Why should anyone invent a component or invest in an innovation in housing that he must fight city hall for permission to exploit? Codes are written to safeguard people, but this does not require that they discourage progress. Many clauses of many codes could be safely rewritten in ways to save people money.

Government has removed many boulders from the road to lower-cost housing, but has scarcely touched others. Why should it cost

more and take longer to transfer title to a *machine* that stays put, such as a building, than to one that can be driven wherever one wants to take it? Both legal and financial customs are factors in the cost of housing. Must we go on forever doing the same old things in the same old ways?

The construction industry's structure has retarded its progress. Small companies produce most of America's housing. Their size limits their credit resources, they must often lay off their workers, they cannot afford costly research and experiments, and they learn too slowly about changes in the state of the building art. Macy's knows in minutes what Gimbel's does to reduce prices, but it takes a long time for tens of thousands of builders scattered across a continent to look over each other's shoulders.

Such simple devices as plastic sheeting to keep the rain off workers have lessened the constraints that weather places on builders. The Woods Hole economists suggested that large companies could afford the research necessary to bring about more such innovations. Large companies might also stabilize their employees' incomes to a greater extent than small concerns can. Possibly they could persuade investors and city governments to remove antique contraints on the construction of homes more quickly too.

Men's fear of change is a basic reason for the high cost of urban housing. Fear of the future underlies the craftsman's opposition to mechanization, his hesitancy to admit newcomers to his union, and jurisdictional disputes between unions. The age of some of our laws and the conservatism of investors amplify this fear. Some of it is the result of forgetfulness and misinterpretations of history's lessons.

Men will gladly risk a trip to the moon because researchers have measured the hazards, and engineers have built a long roster of reliable devices to reduce them. Anthropologists and financiers and statesmen could work together with other specialists to survey the hazards of urban life similarly. Then ways might be found to minimize many of them.

EVERYBODY'S ENVIRONMENT

The founders of our cities regarded air and water the way the Indians did buffalo. There was always more where the last supply came from, and nature took away whatever people polluted. Smog and streams no longer safe to wade in have reminded our generation that nature's bounty is not infinite.

The city is a growing component of a global ecological system that we barely have begun to understand. Instruments in orbiting satellites will soon help environmental scientists detect, trace, and predict global trends. Changes may be accelerated at the same time by such projects as the American Water and Power Alliance's proposal to redistribute water throughout the North American continent. Whole cities may seem in a few more decades to have been badly placed.

Until the weather-makers perfect their art, or we put cities under some kind of glass, nature will meter the input of air to them and handle the output in its whimsical ways. Yet we no longer need to contaminate the winds that blow through cities with such great volumes of foul gas from our vehicles, factories, and homes as we do now. It is no longer necessary to use fuel that gives off smoke and harmful fumes in densely populated places, or to let city dumps smolder day and night. By using electrical power and modern means of refuse disposal, we could lessen the city's pollution of the earth's atmosphere.

With modern technology we also could reduce the city's contamination of water. It enters and leaves the city through umbilical cords designed and built by men. Chemical, mechanical, and

civil engineers are capable now of improving many of both the input and the output lines in ways that would help the whole country get more use and pleasure from its water resources.

Municipal water and sewage systems, of course, are the responsibility of men intent on minimizing taxes. The demands placed on these systems, on the other hand, are determined by men intent on maximizing profits. Each group has given a little and taken a little from the other—but often has taken a little more than it gave. The result has been increasing extravagance with the earth's water.

Trash in the Kitchens

American engineers have built completely closed ecological systems for astronauts. They may have to for our grandchildren, too, if we do not amend some of our methods. We still have alternatives, luckily, such as changing our food-handling, temperature-governing, and plumbing practices.

Although our refuse, garbage, and other solid waste matter already totals 800,000,000 pounds a day, we go right on lugging food into our kitchen in bottles and boxes that cannot be compacted or consumed when emptied. Such wrappings are overtaxing the trucks that haul our trash away. Why do we not tax the producers of non-returnable, non-degradable containers instead of ourselves? They would quickly find substitutes, and we would not have to buy so many garbage trucks.

We heat and cool our homes with machinery we purchase with scarcely any regard for the amount of water they require. We use bathroom and kitchen appliances that send quantities of water down the drain so great they dismay cost-conscious chemical engineers. Although utility and other big companies are spending millions to minimize their additions to pollutants in air and water, we are still paying little attention to the efficiency of things in our homes.

The electric garbage grinder under the kitchen sink in many new homes is an intriguing example of a convenience with side effects that the users tend to disregard. Some cities have forbidden its use because of its effects on their disposal systems; others have required its use, and some even have helped to pay for such grinders. Most of us, unfortunately, take the systems that bring and take things from urban homes for granted and pay scant heed to the problems that may be created elsewhere.

A city must be drained to prevent floods, but spring showers could be used to flush the streets in long hot summers if we kept some of the rainwater in rooftop or other reservoirs. Where storm and sanitary sewers are combined, the tubing must be large enough to carry great surges—but this is not the only possible way to reduce the danger of overflows of untreated sewage into family basements.

Chicago is considering a $100,000,000 test of an imaginative scheme to store storm water

in tunnels 700 feet below the surface, use it to generate electric power, and lift it back to the surface for further use.

Environmental engineers have many ideas. It might be possible, for example, to treat sewage in the big pipes that carry it to discharge points more effectively than nature does after it reaches a river that carries the water to another city downstream. It also might be technically feasible and economically attractive to transport more of the solid matter out of the city in pipelines—and thus reduce the number of trucks disturbing our sleep by banging their way through the streets.

Utility Tunnels

A university campus is a microcosm of a city. There you often find utility tunnels between the buildings. All the pipes and wires needed to serve the occupants of several buildings go through these multi-purpose tunnels. This makes it easier to repair or replace any particular pipe or wire. If we had such tunnels under city streets, traffic would not be held up so often by men with signs saying "dig we must" (such as you see in Manhattan). Might not tunnels reduce our electric, telephone, gas, and other bills?

Alaskans call such big tubes "utilidors." They have made indoor plumbing reliable there, and cost-benefit studies might show they would be good investments in milder climates, too. It might pay, for example, to move some solid matter through vacuum tubing. Do we remove snow from our streets efficiently? Must vehicles in which people ride be delayed so much by men maneuvering and unloading long trucks? Could not many more things flow through pipes than do now? In the nuclear age, tunnels under the streets could also shield people from radiation.

Better machinery for boring holes through the earth may be no more impossible to produce than vehicles for venturing into space. The high-speed ground transportation system that engineers have proposed for the corridor between Boston and Washington will almost certainly require miles of tunneling. New methods might lower the cost of going underground as they have that of flying.

Every system considered by the environmental engineering panel at Woods Hole could be improved in a manner that would help solve more than one problem, if experts worked together the way they are striving right now to avoid contaminating other planets. Heretofore we have tended much too often to attack problems posed by the inputs and outputs of urban communities separately rather than together. Cities have failed to weigh the advantages of doing things differently both to their own people and to others living beyond the suburbs.

Major improvements can be made in everyone's environment, this panel found, by (1)

using space-age technology more extensively, and (2) achieving a greater sense of community between public and private sectors of our economy.

When the poor people of Paris cried for bread long ago, Marie Antoinette suggested that they eat cake because she was poorly informed about prices. When riots broke out on hot American streets in 1966, a physicist fresh from Woods Hole suggested that it might be cheaper to cool people's homes than to cool their streets. Scoffers at such ideas may be as poorly informed as Marie Antoinette was about prices.

Air-conditioning is a new kind of cake, now becoming cheaper. Those humming boxes you still see in the windows of the well-to-do are makeshift devices. New buildings are being cooled more efficiently. Some structures designed to be air-conditioned cost less because ceilings do not have to be so high. With utility tunnels, cooling several buildings from one plant might be just as practical as heating several from one plant.

The cost of keeping people off the streets with amenities in their homes is difficult to compare with the cost of driving them home with guns—but electronic data-processors now make comparisons overnight that formerly kept bookkeepers perched on high stools for years. There are probably cheaper ways than air-conditioning to alleviate the pressures on the newcomers, the young, the aged, and the impoverished people now squeezed together in cities, but who knows what they are?

SOMETHING OLD AND SOMETHING NEW

Like the mountains and plains, the city has many lovers. What other synthetic thing have poets sung to more often? Cities have legends and ghosts that only time can produce. Men have spent vast sums re-creating such places as Williamsburg, because people enjoy historic as well as wholly new surroundings.

Men and women with hearts committed to the city's diversity and mystery gravitated to the panel at Woods Hole that studied the rehabilitation of old neighborhoods. They thought of the beauties of Louisburg Square, Georgetown streets, and many other charming niches in American cities. Even in some of the most frightful frameworks, they saw a kind of socio-economic life struggling to survive.

"I have lived comfortably in Princeton in a 200-year-old house, and it is not really a lot different from the four-year-old house I am living in in Washington today," Donald F. Hornig, the President's advisor for science and technology, told the group, "and in some respects it is superior."

Families working together can accomplish more than families working apart. Basements once filled with junk and trash become community meeting places, adult education classrooms, and play areas for children formerly in the streets.

No neighborhood is so woebegone that nobody loves it. Westerners fondly recall and have restored the shanties in their ghost towns. New Yorkers sing about the Bowery even though some do not go there any more. The corner druggist and the Third Avenue saloon minister to human wants that are hard to gratify in supermarkets. Many persons prefer a flat over a Chinatown restaurant, or a cubby-hole in Green-


CLOSE
OUTS
GUITARS
STRINGS
BUTTON
PIANO
ACCORDIONS
VIOLINS
OPEN
CLOSING OUT

wich Village, to a cottage in a suburb hours away from a big public library, the art shows, Broadway, and a major league ball park.

Technology can serve those who prefer familiar faces and places as well as those eager to escape from them. It has given many people windows from which they can see Lake Michigan or the Golden Gate bridge. It can also help those who cannot afford such luxuries. It can be employed to save the wild flowers as well as those that bloom only in formal gardens.

Topsy-Turvy Research

Rehabilitation is after-the-fact action, desirable in many neighborhoods and imperative in some. Millions of people will sleep tonight in dilapidated, overcrowded structures without proper sanitary facilities. Much of this housing, unfortunately, is too decrepit to be salvaged. Even if all of it were salvaged, the supply would be inadequate for our increasing urban population.

The Summer Study group declared new housing should be designed for the kinds of people who live in blighted areas now, yet be as flexible and adaptable to future needs as possible. This is a challenge to sociologists as well as to architects and engineers—but ours is an age of analysis in which once impossible feats are becoming almost commonplace.

Although the homesteaders in Nebraska had little to work with except sod, they built houses from it in which families prospered. We now have a wide range of options: The hewers of wood offer it now in new and attractive forms, the suppliers of metal can produce it to more specifications, and the glassmakers need only be told what we want from them. Corporations that exploit natural resources have reduced the cost and improved the quality of many of the products that they offer to builders. Most of this research, however, has been piecemeal rather than comprehensive. Its sponsors' purpose was to increase sales of certain components of housing, rather than to make the final product more functional.

"We could not have gotten into space," no less keen an observer than Dr. Hornig has testified, "by the piecemeal development of the parts of spacecraft with the hope that, one way or another, they would be put together into something that would fly and could rendezvous." Yet that is the way we have been trying to improve housing.

The Summer Study group recommended that the Department of Housing and Urban Development orchestrate the efforts of scientists, public officials, academicians, and private entrepreneurs, as the National Aeronautics and Space Administration has done. Like that agency, HUD has inherited experienced agencies and skilled personnel. It can benefit, too, from what

older brothers have learned about health services, transportation, construction, hydrology, and other facets of urban problems.

The United States, however, has no national, prestigious institute or center of knowledge regarding urban technology. NASA had the laboratories of the National Advisory Committee for Aeronautics to turn to for help. The city was invented when science was still primitive and the coupling between them has remained loose. Both business and labor have resisted federal support of research applicable to housing people less expensively.

A government center could identify, describe, and assign specialists to plug holes in the current state of the building art. It could initiate the development of entirely new technologies. It could help transfer knowledge from laboratories to persons responsible for urban structures and systems. It could stimulate colleges to offer short courses, summer programs, and fellowships for students concerned with the mystifying aspects of urban programs. It could assist the small builder by assembling, evaluating, and distributing the information that he needs to compete with a large company.

Agriculture, too, was long dominated by small businessmen unable to study and experiment with enough new ideas. Government-sponsored research and development helped to multiply the fruits of the farmers' labor. Thanks to the Department of Agriculture's energetic dissemination of new knowledge in its bulletins, by word of mouth, and by demonstrations in the fields, we acquired food surpluses.

The space agency not only shares its discoveries with American industry in such ways, but also uses new data distribution techniques. The output from its research is stored on compact film from which data can be retrieved in a jiffy. Profiles of particular manufacturers' interests are prepared, from which their requirements are matched with the inventory of available information. Similar techniques could speed innovations in urban affairs.

The construction industry accounts for about eleven percent of the gross national product, but has been one of the slowest to develop and use modern data banks. The Woods Hole group proposed that the national government provide a yardstick for builders such as TVA has been for the power industry. This might be done by creating some kind of quasi-public institutions and procedures to provide opportunities for innovations and to demonstrate new techniques in urban development. The city builders' knowledge of how to fit new things together is still largely empirical. We are surrounded by visible evidence of its inadequacy to meet people's rising aspirations.

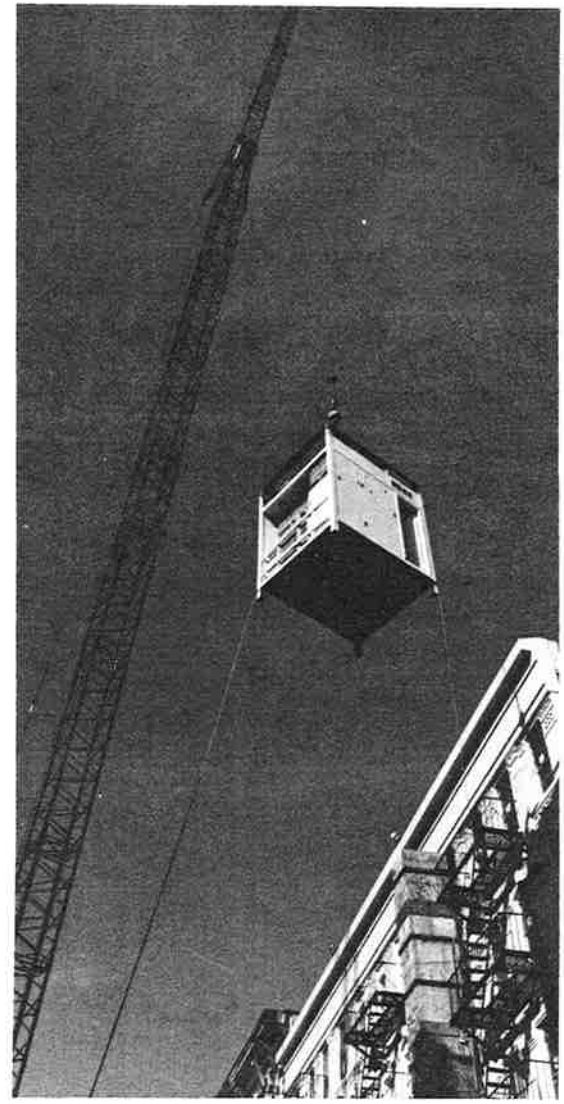
A three-week study by four dozen men and women seldom can produce final answers to great questions, but the group that met at Woods Hole suggested many possible ways to go about finding answers.

Urban Conservation

A "rehab" program lets people stay where they are. There are fewer relocation heartaches than when "skull crackers" knock down a neighborhood's landmarks. There is less need for expensive changes in transportation, sanitation, and other service networks. Making an old structure fit for human occupancy again, moreover, is often the cheapest, quickest way to revive the occupants' spirits.

The senior citizen involved in such a program may find his or her know-how valued again. The unskilled laborer employed in the resuscitation of his own neighborhood may gain experience and employment opportunities that will enlarge his earning power. A well-planned rehab project can help the children of the poor acquire upward social mobility and that, in addition to providing shelter, is one of urban housing's proper functions.

Imaginative architects and ingenious engineers are finding many ways to make obsolete structures pleasantly habitable again with modern tools and materials. Catholics in New Orleans, Protestants in Boston, and the city-wide church federation in Chicago are helping to provide non-profit housing for low-income people in such ways. Lending institutions and the building industry, too, are beginning to see potentialities for them as well as for society in rehabilitation efforts.



The Woods Hole enthusiasts for tonics rather than death sentences for aging housing agreed that society could and should act to raise the incomes of its least fortunate constituents. Many thought the government could and should provide subsidies for those unable to buy or rent decent homes. But they also contended that government could do more than it has to encourage progress in the art of restoring old neighborhoods, and thus to lighten their requirements from welfare and other systems.

In New York City a quick way to modernize old brownstone-front tenements is being demonstrated. Persons living in them are made "building captains" to find out what the occupants would most like to have, what they can contribute, and what they need to be told and given. After such a survey every partition and permanent attachment inside an old shell is ripped loose and tossed into dump trucks. New prefabricated partitions, windows and doors are installed. A crane lowers modern, fully assembled kitchen and bathroom units to the first floor through a hole in the roof, then to the second floor, and so on up. Neighborhood contractors participate, and neighborhood merchants sell more new brooms.

There has been less vandalism than was feared, or than might occur if one man or company was doing the work without the assent and help of the whole neighborhood. There will be fewer calls for the police because new glass doors have lightened hallways, and new security systems help the tenants bar unwelcome visitors. There will be fewer mice, and less litter for street brawlers to kick around, because drop shafts for garbage and refuse have been put into sturdy although aged shells. The whole city will benefit because homes that were functioning as poorly as a car with worn-out tires, sparkplugs, and springs have been made operable again—and far more conducive to family viability.

MEANINGFUL EXPERIMENTS

When our plight is examined as it was at Woods Hole, the United States resembles a country described by Wilfred Owen of the Brookings Institute: "At the national level the inhabitants were very rich but at the local level they turned out to be quite poor. And, as luck would have it, they all lived at the local level."

An experience shared by many scientists suggests the difficulty of raising that level: A physicist who ventures into biology quickly finds that the constraints of physics still apply in that field. A biologist who goes on to study social organisms discovers that he still is subject to both biological and physical constraints. The urbanist is hampered by all these plus political, geographical, financial, and institutional constraints. He faces both natural and man-made obstacles.

These add up to so many parameters that scientists have tended to turn away from the city's woes. Their achievements sometimes have increased its problems. Their skills are becoming increasingly applicable to many of them. Yet urban challenges are still seldom depicted in equations on their blackboards.

No single, simple innovation is likely to be helpful enough by itself. The Romans staged circuses to distract people from their hardships. Nearly all cities have bolstered their citizens' morale with monuments. Most American cities also have parking meters to give glimmers of hope to motorists impatiently searching for a place to get out from behind the wheel. When radio was new, Mayor Fiorello LaGuardia used it during a newspaper strike to read the comics to New York's children, but he always concluded his broadcasts by appealing for "patience and fortitude."

Hundreds of communities have tried urban renewal programs. Some sponsors have confused "housing renewal" with urban renewal, and forgotten about the services of family doctors, little candy stores, and bus lines. Some new housing is scarcely fit for occupancy because of traffic snorts, smells, and surges. Such efforts have disappointed even their champions.

From the social and physical ferment stirred up by urban renewal and other programs, nevertheless, specialists in the systems and subsystems that keep cities alive have learned many lessons about the interfaces between the bits and pieces of cities. Thanks to these experiments, we can now enlarge and improve both the hardware and the software.

Information Processing

"The name of the urban game," as one of the Woods Hole conferees pointed out, "is information processing." This is another name, too, for advances in science. Its greatest men stand like Newton on the shoulders of other men. Those whom we honor with monuments are those who remembered and analyzed what others observed, then applied that information to their generations' questions. This is a game that more men understand now. We can store, retrieve, disseminate, and apply large quantities of information to our problems more quickly than our predecessors could.

Sometimes our goals have been too modest. The Russians put platforms for their instruments and men into orbit before we did. Thus challenged, our space experts set difficult goals for themselves.

Our goals in space were set in the light of (1) the performances required from *black boxes*, (2) estimates of the time it would take to meet them, and (3) the costs and the benefits. The decision to put Americans on the moon was not made until after the space agency was created. Some of our experts' first estimates were too optimistic, and there were embarrassing failures at first at Cape Kennedy because some of the systems in some of the rockets did not perform as required.

Although no one has landed on the moon yet, the astronauts are not twiddling their thumbs. They are going aloft on shorter missions. They are learning more about radiation belts, the solar winds, and other phenomena. A similar "learning curve" can help us conquer poverty in our cities.

The beauty of some European cities has long challenged our architects. The stench of our slums is a challenge to all men of good will. The Department of Housing and Urban Development plans now to help us start upward along a learning curve comparable to the one being followed into the solar system.

Last fall the Congress authorized the new department to help cities of all sizes finance comprehensive assaults on some of the nation's blotches. These cities will pit multi-weapons against the multi-reasons for human misery in certain dismal neighborhoods. These neighborhoods will be, in effect, pilot plants for urban progress.

Each city that participates in this new approach to urban renewal will designate its own "Model City Agency." The federal government will help this local agency pay for planning that embraces both physical and social structures.

The local programs that the federal government supports will be designed to increase the supply of standard housing at low and moderate cost. They also will include measures to enhance people's health, employment, educational, and other opportunities. They will affect whole neighborhoods in ways that will contribute to the healthy growth of the whole city.

Some of the enlargement of the supply of functional urban shelters will be brought about by rehabilitating old shells, and some by erecting completely new buildings. The objective will be to give more housing options to people at all income levels.

The local agency will coordinate the use of money available from federal government sources for hospitals, for beautification, for vocational training, for community action, and for other factors in the quality of urban life. The Department of Housing and Urban Development

will make supplemental grants to support special activities that local agencies may find necessary, and to help meet the cost of promising innovations such as neighborhood health centers.

These model city programs will be experiments in innovation. They will recruit and mobilize local resources and skills. Their goals will demand a wider spectrum of talents than previous renewal efforts.

Such local programs will serve purposes analogous to those of the astronauts' pre-Apollo flights. They will provide models for social scientists to study. They will clarify the capabilities of urban systems and the interactions between them. They may suggest major changes in the research strategy of urban pioneers comparable to those made in our space program.

The first plan to put our men on the moon, for example, called for them to land there with enough propulsive power to return to earth. That plan was discarded when a systems analysis showed that a more round-about procedure would be preferable. The astronauts now scheduled to set foot on the moon will leave part of the propulsive power necessary to come home in orbit around the moon until they have completed their tasks on the lunar surface.

Discoveries made in neighborhoods in the model cities may expose flaws in the blueprints men are drawing now both to remodel old cities and to build completely new ones. From this series of real-life tests of new ways of approaching, managing, and completing great undertakings, men will find out more about the complexities of life when people are clustered together. Everyone will see the costs and benefits of comprehensive efforts, the successes and the failures. Hence, from what happens in these model cities, men in every city may learn more than anyone can say for sure today about how to help dense masses of people live together safely and happily.

The Problem Is People

The nation's urban population is close to the number of cells in a man's brain. The city, the Summer Study's chairman concluded, is an even more fascinating challenge to science than the human brain.

"Our inefficient and inhumane slum system is maintained at exorbitant cost," one panel reported. "Failure to understand the links between sub-standard dwellings, health, education, recreation, sanitation, transportation, employment, and other services results in exploitative shelter cost in an inadequate physical and social environment." The model cities will help us measure that cost against other costs and clarify the links between people's requirements.

We have fought poverty for many years in many ways. We have declared men's rights, taxed incomes, organized labor, and even forbidden alcoholic beverages. No single weapon, we see now, will bring victory in this war. In

the model cities, breeding places of poverty will be attacked simultaneously from several angles. The United States now has more resources and skills than most urbanists have realized, and great things can be done more quickly now.

Men invented the city. They will go on working on it with or without the help of science. It is a garden in which members of every academic discipline can work productively. It is a frontier ripe for the approaches, the objectivity, and the tools of scientists. It is one on which they can show their neighbors that their knowledge can be a liberalizing, humanizing force. Linked to the inspirations of artists, the scientists' skills can be used to make one of mankind's oldest and most treasured inventions truly operable again.

Announcing that we would go to the moon enticed men who then were barely on speaking terms with each other in the corridors of technology to pool their know-how and efforts. They then began, in the late Dr. Hugh Dryden's words, to "move forward with urgency."

President Johnson has pointed to another alluring goal, possibly more distant, but certainly no less essential to our country's contentment. The American city, he has reminded us, must be made "a place where each of us can find the satisfaction and warmth which comes only from being a member of the community of man."

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"Men come together in cities in order to live. They remain together to live the good life."

Aristole

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